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Abstract

Background

The objective of this study was to validate categories of cognitive functioning using data from the 2009 Canadian Community Health Survey (CCHS)—Healthy Aging Cognition Module.

Data and methods

Four measures of cognitive functioning—immediate and delayed recall (memory), and animal-naming and the Mental Alternation Test (executive functioning)—were coded into five categories for the Canadian household population aged 45 or older. The scores for each measure were standardized to t-scores that controlled for age, sex and education. Respondents were classified into five cognitive functioning categories. Cross-tabulations, stratum-specific likelihood ratios and multinomial logit regression were used to assess associations between levels of cognitive functioning and various health outcomes: self-reported general and mental health status, memory and problem-solving ability, activities of daily living, life satisfaction, loneliness, depression, and chronic conditions.

Results

Results supported the use of five levels of cognitive functioning for all four outcomes on the CCHS—Healthy Aging sample overall and by age group (45 to 64, 65 or older) and language group (English, French).

Interpretation

These categories can be used in future work on cognitive functioning based on the CCHS—Healthy Aging.

Keywords

activities of daily living, cognitive disorders, data collection, memory disorders, mental recall, survey methods

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While cognitive decline is not an inevitable consequence of aging, it is more prevalent at older ages.[1] In 2006, one in seven Canadians (13.7% of the total population) was aged 65 or older.[2] Among these seniors, the percentage aged 80 or older continues to grow, as does the number of centenarians. These trends suggest that a rise in the prevalence of cognitive impairment can be anticipated.

Mild cognitive decline heightens the risk of further deterioration,[3-5] but seniors with relatively low levels of impairment may not be identified in cognition studies, which typically focus on people diagnosed with dementia.[6] Nonetheless, a substantial share of the senior population is affected. According to the 1991 Canadian Study of Health and Aging (CSHA), about 17% of Canadians aged 65 or older had mild impairment, often labelled "cognitive impairment—no dementia or CIND."[7] Similarly, data from the Health and Retirement Survey indicate that 22% of Americans aged 71 or older had CIND.[6] Consequently, examination of the prevalence of various levels of cognitive well-being is warranted.

The last national survey to include measures of cognitive functioning among seniors was the CSHA.[7] The present analysis uses data from the Cognition Module of the 2009 Canadian Community Health Survey (CCHS)—Healthy Aging to validate a categorization of levels of cognitive functioning in the Canadian household population aged 45 or older. Five categories of four measures of cognitive functioning are examined for the entire sample, and by age group and language.

Methods

Data source

The 2009 Canadian Community Health Survey (CCHS)—Healthy Aging is a population-based cross-sectional survey. The sampling frame consisted of people aged 45 or older living in private dwellings in the ten provinces. The survey excluded residents of the three territories, some remote regions, institutions, Indian reserves or Crown lands, and military bases (military and civilian), and full-time members of the Canadian Forces. Data collection took

place from December 1, 2008 through November 30, 2009 using Computer-Assisted Personal Interviewing.

The purpose of the Cognition Module of the survey was to examine cognitive functioning (as opposed to cognitive impairment) across the lifespan. The Module was administered in English and French to *non-proxy* respondents who consented to participate. This differed from the main component of the survey, for which proxy responses were accepted if the mental or physical health of selected participants prevented them from completing the interview (2.2% of the sample). Preliminary analyses suggested that respondents interviewed by proxy were more likely than those who answered on their own behalf to have dementia or to have suffered a stroke. Exclusion of these respondents from the Cognition Module means that the data may slightly overestimate cognitive functioning in the household population.

The overall response rate to the Cognition Module was 62.3% (N = 25,864), compared with 74.4% (N = 30,865) for the entire CCHS—Healthy Aging.

Cognition Module variables

Previous studies have used clinical and non-clinical means to assess cognitive functioning. The Mini-Mental State Examination (MMSE)[8] and the Modified Mini-Mental State Examination (3MS)[9] are the instruments most commonly employed in clinical settings.[10-12] However, when clinical assessment is not possible (in large, survey-based studies), other measures must be used.

Cognition may be defined in terms of domains, including memory and executive functioning (for example, planning, problem-solving, and anticipation of outcomes).[13] The 2009 CCHS—Healthy Aging Cognition Module includes four cognitive tasks: two relating to memory (immediate and delayed recall) and two relating to executive functioning (animal-naming and the Mental Alternation Test). These tasks are similar to those used in other population-based surveys,[14] as well as in community-based studies.[15-18]

Recall tasks

A modified version of the Rey Auditory Verbal Learning Test (RAVLT) was administered to CCHS—Healthy Aging respondents. The test involves memorizing 15 common unrelated words (for example, drum, curtain, bell) and performing two recall trials: one immediate and one delayed. The delayed recall trial took place five minutes after the immediate recall trial (the other cognitive tasks were performed between the recalls). Survey-administered tests of immediate and delayed recall have been shown to be related to each other in a consistent way, to have similar consistency across racial groups,[19] and to have good construct validity.[20]

Animal-naming

To test semantic fluency, respondents were given one minute in which to name as many items as possible from a category, in this case, animals. Different types of the same species were counted (for example, robin and parrot counted for two points), but different varieties of the same type (for example, American robin and European robin) received only one point. The animal-naming test has been widely administered, demonstrated to be appropriate for evaluating different populations, and sensitive to different types of brain abnormalities, and it correlates with other tests of verbal fluency.[21]

Mental Alternation Test

The Mental Alternation Test (MAT) assesses processing speed.[17,22] Respondents are asked recite the alphabet, and then to count from 1 to 26. They then have 30 seconds in which to alternate between numbers and letters in the sequence 1-A, 2-B, 3-C, etc. The maximum possible score is 51.

Of those who completed any part of the CCHS—Healthy Aging Cognition Module, 85.9% responded to the immediate recall, 75.5% to the delayed recall, 92.6% to animal-naming, and 90.9% to the Mental Alternation Test. Existing French versions of the recall and animal-naming instruments were used for interviews conducted in French; the English version of the MAT was translated into French.

The various measures reflect independent markers of cognitive functioning, and may have different associations with health outcomes. For example, memory impairment may be important for the early detection of dementia,[23] and declines in executive functioning, as well as memory, may influence activities of daily living.[24] It is also possible that subgroups respond differently to the various measures of cognitive functioning. For instance, people aged 45 to 64 may not demonstrate the same patterns of cognitive functioning as seniors, and patterns may vary by language group.

Socio-demographic characteristics

Cognitive functioning is typically evaluated in terms of age, sex and education, factors known to be related to cognitive performance.[6,7,10-12,25-28] For instance, results from the English Longitudinal Study of Aging revealed better cognitive performance among younger people, women and individuals with higher education.[14]

Respondents to the CCHS—Healthy Aging reported their sex, age in years and highest level of education. Ten education levels were specified. The language of the interview (English or French) was recorded by the interviewer; respondents who did not complete the CCHS—Healthy Aging in either English or French were excluded from the Cognition Module.

Analysis variables

Numerous physical and psychological correlates of impaired cognitive functioning have been identified (Table 1). Cognitive difficulties have been associated with lower self-rated health,[29,30] depression,[31-33] loneliness,[34,35] decreased life satisfaction,[36,37] and reduced ability to perform instrumental activities of daily living.[24,38-40] People with

Table 1
Selected characteristics of 2009 Canadian Community Health Survey—Healthy Aging Cognition Module respondents, household population aged 45 or older, Canada excluding territories

Characteristic	%	Mean	Standard error
Socio-demographic			
Sex			
Women	51.9	..	..
Men	48.1	..	..
Age	..	60.5	0.04
Marital status			
Married	73.5	..	..
Single	26.5	..	..
Language			
English	76.7	..	..
French	23.3	..	..
Education			
Grade 8 or lower (Quebec Secondary II or lower)	9.2	..	..
Grades 9 or 10	8.0	..	..
Grades 11 to 13	3.9	..	..
Secondary graduation	19.1	..	..
Some postsecondary	5.4	..	..
Trades certificate/diploma	13.7	..	..
College/CEGEP certificate/diploma	17.1	..	..
University certificate below bachelor's degree	3.2	..	..
Bachelor's degree	12.2	..	..
University certificate above bachelor's degree	8.3	..	..
Province			
Newfoundland and Labrador	1.7	..	..
Prince Edward Island	0.4	..	..
Nova Scotia	3.1	..	..
New Brunswick	2.4	..	..
Quebec	24.6	..	..
Ontario	38.3	..	..
Manitoba	3.4	..	..
Saskachewan	2.9	..	..
Alberta	9.3	..	..
British Columbia	13.8	..	..
Cognitive outcomes			
Immediate recall	..	5.5	0.10
Delayed recall	..	4.0	0.12
Animal naming	..	17.9	0.03
Mental Alternation Test	..	22.6	0.03
Health outcomes			
Self-perceived health			
Excellent/Very good/Good	84.8	..	..
Fair/Poor	15.2	..	..
Self-perceived mental health			
Excellent/Very good/Good	94.2	..	..
Fair/Poor	5.8	..	..
Life satisfaction			
Not low	84.4	..	..
Low	15.6	..	..
Likelihood of depression			
Less than 0.9 probability	94.3	..	..
0.9 probability or higher	5.7	..	..
Loneliness			
Not high	87.8	..	..
High	12.2	..	..
Activities of daily living			
No problems	90.2	..	..
Mild/Moderate/Severe/Total problems	9.8	..	..
Memory			
Able to remember most things	75.9	..	..
Somewhat forgetful/Very forgetful/Unable to remember anything	24.1	..	..
Ability to think clearly and solve problems			
Able to think clearly/solve problems	91.9	..	..
Having a little/some/great deal of difficulty	8.1	..	..
Chronic conditions			
Neurological disorder	2.7	..	..
Vascular disorder	44.1	..	..
Psychiatric disorder	10.5	..	..

.. not applicable
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module

cerebrovascular disease,[29] diabetes,[33,41-44] hypertension,[45] or stroke[12,46] are more likely to be cognitively impaired than are individuals without these conditions. Psychiatric disorders have also been associated with poor cognitive functioning.[47,48]

Self-perceived health

CCHS—Healthy Aging respondents were asked about their general and mental health: "In general, would you say your [mental] health is. . . ." The response options—"excellent," "very good," "good," "fair," and "poor"—were dichotomized to reflect good (excellent/very good/good) versus poor (fair/poor) health.

Activities of daily living

Questions about respondents' ability to perform activities of daily living (ADL) were based on the OARS Multidimential Assessment Questionnaire.[49] An overall summary measure of ratings on the ADL capacity-instrumental and physical dimensions was derived. A score of 0 indicates no functional impairment; 1 = mild impairment; 2 = moderate impairment; 3 = severe impairment; and 4 = total impairment. Responses were dichotomized to identify respondents with no impairment versus mild/moderate/severe/total impairment.

Life satisfaction

On a scale from 0 to 10, with 0 representing very dissatisfied and 10, very satisfied, respondents were asked: "How do you feel about your life as a whole right now?" Scores were dichotomized to identify those whose life satisfaction was low (at least 1 standard deviation below the mean) versus not low.

Depression

The CCHS—Healthy Aging measure of depression is a shortened version of the World Health Organization Composite International Diagnostic Interview (CIDI) Scale, which is based on the DSM-III-R and the Diagnostic Criteria for the Research of the ICD-10. The depression subscale pertains to people who felt depressed or lost interest in

things for two or more weeks in the past year. For the CCHS—Healthy Aging, a derived variable was created based on the depression score, indicating the probability that respondents would have been diagnosed as having experienced a major depressive episode in the past 12 months if they had completed the Long-Form CIDI. A probability of 0 was assigned to respondents who replied negatively to the stem question (did not have depression for two or more weeks in the past year); a cut-off value of 0.9 was used to distinguish those with a high probability of depression (above 0.9) from those with a lower probability.

Loneliness

The 3-Item Loneliness Scale[50] measures an individual's reported loneliness. On a 3-point Likert scale ("hardly ever," "some of the time," and "often"), CCHS—Healthy Aging respondents answered the questions: "How often do you feel:

- that you lack of companionship?"
- left out?"
- isolated from others?"

Higher scores indicate greater loneliness. Scores were dichotomized to identify those with high loneliness (at least 1 standard deviation above the mean) versus not high loneliness.

Self-reported cognition (Health Utilities Index)

The Health Utilities Index (HUI) Mark III assesses functional health status in eight domains: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain.[51,52] The HUI has been shown to have strong reliability and validity in general,[53] as well as for patients with lower cognitive functioning.[54]

Only the cognition subscale of the HUI was pertinent to the current study. The items of interest were: "How would you describe your usual ability to:

- remember things (able to remember most things; somewhat forgetful; very forgetful; unable to remember anything at all)."
- think and solve day-to-day problems (able to think clearly and solve problems; having a little difficulty; having some difficulty; having a great deal of difficulty; unable to think or solve problems)."

Items were dichotomized as "able to remember most things" versus at least "somewhat forgetful," and "able to think clearly and solve problems" versus having "at least some difficulty."

Chronic conditions

Respondents were asked if they had been diagnosed with specific long-term health conditions. Conditions relevant to the current analysis were grouped into neurological (Alzheimer's Disease or other dementia, Parkinson's Disease, effects of stroke), vascular (high blood pressure, diabetes, heart attack, heart disease), and psychiatric (mood disorder or anxiety) disorders.

Analytical techniques

T-score creation

Selecting cut-points to identify impairment implies that definitive lines demarcate "normal" from "dysfunctional" scores. It is more likely that cognitive functioning operates on a continuum and that several categories are more appropriate as indicators of impairment.[4] Consequently, for this analysis, multiple categories of cognitive functioning were identified.[55] T-scores that control for age, sex and education can be calculated for each cognitive measure. Using the sample data for the current study, five categories of cognitive functioning were created, representing t-scores of 0 to 34, 35 to 44, 45 to 54, 55 to 64, and 65 or more.

To generate t-scores from the results of each of the four cognitive tasks, raw scores were converted to scaled scores (mean = 10, standard deviation = 3); higher scaled scores indicate better performance.[55] Scaled scores were regressed separately for each task on age, sex and education. In this manner, equations were created for each dependent variable (cognitive outcome) in the form:

$$DV = \text{intercept} + b(\text{age}) + b(\text{education}) + b(\text{gender})$$

Each respondent's predicted scaled score was generated from this equation (that is, independent of age, sex and education). The respondent's predicted score was subtracted from the actual scaled score to determine the residual, indicating how well the individual performed, compared with what would be expected based on his/her age, sex and education. Finally, residual scores were converted to t-scores with the following equation:

$$T = \{[(\text{residual}/\text{standard deviation of the residual}) \times 10] + 50\}$$

Thus, the t-scores are independent of age, sex and education; are normally distributed; have a mean of 50 and a standard deviation of 10; and are independent of a unit of measurement.[55]

Validation

Once t-scores were created and individuals were assigned to one of the five cognitive function categories, the first step in empirically validating the categories was to examine cross-tabulations of the categories by health outcome.

Stratum-specific likelihood ratios (SSLRs) were calculated to determine the accuracy of assigning individuals to levels of cognitive functioning based on the health outcomes.[56-58] SSLRs are generalizable and independent of actual probabilities in the population.[59] The likelihood that people in each cognitive functioning category (stratum) will experience a certain outcome (for example, fair/poor self-rated health) is given relative to their likelihood of experiencing a positive outcome (in this example, excellent/very good/good self-rated health), according to the formula:

$$SSLR = (x_{1g}/n_1)/(x_{0g}/n_0)$$

where x_{1g} is the number of people with the health outcome (fair/poor health) in the gth stratum; n_1 is the total number of people with the health outcome; x_{0g} is the number of people without the health outcome (in good health) in the

gth stratum; and n_0 is the total number of people without the health outcome.

An SSLR of 10 or more indicates that the health outcome is highly likely; an SSLR below 0.1 indicates that it is highly unlikely.[56,57] It is anticipated that SSLRs would be high when a poor health outcome is more likely, and low when a poor health outcome is unlikely.

The final step was to examine all relevant health variables as predictors of cognitive functioning, comparing lower levels of functioning to the highest category (t-scores of 65 or more) for each cognitive outcome. Because the dependent variable (cognitive functioning category) comprised five levels, a multinomial logit regression analysis was used. The odds of reporting a health problem (for example, fair/poor health) should be greatest for those in the lowest (versus the highest) cognitive functioning category, with odds decreasing for those in progressively higher categories of functioning.

Results are presented only for the immediate recall outcome; results were similar for delayed recall, animal-naming, and the MAT (Appendix Tables A to I). Correlations between the four outcome variables were moderate (immediate recall with delayed recall, r = .69; immediate recall with animal-naming, r = .36, immediate recall with MAT, r = .34; delayed recall with animal-naming, r = .33, delayed recall with MAT, r = .30; animal-naming with MAT, r = .45; all p's $\leq$ .001). Survey sampling weights were applied to all point-estimates to account for the complex survey design of the CCHS—Healthy Aging.

Because the response rate for the Cognition Module was lower than that for the full CCHS—Healthy Aging, separate sampling weights were created for use with the cognitive outcome variables sample. All analyses were performed with SAS 9.1 and SAS-callable SUDAAN. Standard errors in modelling were computed using a bootstrapping technique.[60]

Results

Descriptive statistics

As expected,[55] the distribution of immediate recall scores across cognitive functioning categories was normal, with the most common category (39% of respondents) being t-scores in the 45-to-54 range (Table 2). Approximately 6% of respondents scored in the lowest category, and 8% in the highest.

People who reported fair/poor general health were more likely to have relatively low immediate recall scores. About 9% of them had scores in the lowest category, compared with 6% overall. Conversely, 5% of those with fair/poor health had immediate recall scores in the in the highest category, compared with 8% overall. This pattern was even more pronounced for self-reported mental health. Similarly, relatively high

Table 2
Percentage distribution of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by immediate recall score and selected health characteristics, household population aged 45 or older, Canada excluding territories

	Immediate recall t-score				
Health characteristic	Low 0 to 34	35 to 44	45 to 54	55 to 64	High 65 or more
			%		
Total	**5.6**	**24.5**	**39.2**	**23.0**	**7.8**
Self-perceived health					
Fair/Poor	8.5	28.6	39.8	18.1	5.1
Excellent/Very good/Good	5.1	23.8	39.1	23.8	8.1
Self-perceived mental health					
Fair/Poor	14.9[E]	32.2	32.3	16.6	3.9[E]
Excellent/Very good/Good	5.1	24.1	39.6	23.4	7.9
Activities of daily living					
No problems	5.3	24.1	39.2	23.5	7.9
Mild/Moderate/Severe/Total problems	8.6	28.4	39.3	18.4	5.3[E]
Life satisfaction					
Low	7.8	30.7	38.2	18.0	5.3
Not low	5.2	23.4	39.4	23.9	8.0
Depression					
0.9 probability or higher	5.8[E]	25.7	39.3	18.3	10.8[E]
Less than 0.9 probability	5.5	24.4	39.3	23.4	7.4
Loneliness					
High	9.1	28.4	36.8	19.5	6.3
Not high	5.1	24.0	39.6	23.5	7.8
Memory					
Able to remember most things	5.0	24.0	39.5	23.6	7.9
Somewhat forgetful/Very forgetful/Unable to remember anything	7.6	26.4	38.2	21.0	6.8
Ability to think clearly and solve problems					
Able to think clearly/solve problems	5.2	23.8	39.4	23.7	7.9
Having a little/some/great deal of difficulty/unable	10.5	33.9	36.6	14.8	4.3[E]
Neurological disorder					
Yes	9.0[E]	30.3	41.1	16.0	F
No	5.6	24.4	39.1	23.2	7.7
Vascular disorder					
Yes	5.0	24.0	41.0	23.0	7.0
No	6.1	25.0	37.9	22.9	8.1
Psychiatric disorder					
Yes	9.6[E]	26.3	37.6	19.3	7.2[E]
No	5.2	24.3	39.4	23.4	7.7

[E] interpret with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be reported (coefficient of variation greater than 33.3%)
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

percentages of people who reported difficulties with activities of daily living, lower life satisfaction and loneliness had low immediate recall scores. By contrast, no pattern emerged for depression.

The HUI cognitive functioning variables were associated with immediate recall scores. Respondents who reported that they were at least somewhat forgetful and who had at least some difficulties thinking clearly and solving problems were more likely than others to have immediate recall scores in the lowest category and less likely to have scores in the highest category.

The presence of a neurological or psychiatric disorder was related to cognitive functioning. Relatively high percentages of people who reported such conditions had low immediate recall scores. However, this was not the case for people with vascular disorders.

Stratum-specific likelihood ratios

In general, the stratum-specific likelihood ratios (SSLR) supported the cognitive functioning categories: the higher their immediate recall score, the less likely were respondents to have negative health characteristics. (Although the SSLR patterns were generally as anticipated, some differences emerged for delayed recall, animal-naming and MAT–Appendix Tables D to F).

SSLRs for fair/poor self-rated general and mental health, difficulties with activities of daily living, low life satisfaction and loneliness decreased as immediate recall scores rose (Table 3). In general, depression also followed the expected pattern, with the highest SSLR for the lowest immediate recall score category. The two HUI cognition variables also demonstrated the anticipated pattern.

Similarly, the SSLRs for neurological and psychiatric disorders followed the expected pattern in that the likelihood of the conditions was associated with low immediate recall scores; no association was shown for vascular disorders.

Multinomial logistic regression

The final step was to examine the odds of being in a low immediate recall score category given the presence of a negative health characteristic. The highest t-score category was set as the reference group (Table 4). As expected, scoring in the lowest immediate recall category was associated with the highest odds of poor health. For instance, compared with people whose immediate recall scores were in the highest category, those with scores in the lowest category had more than twice the odds of being in fair/poor general health, almost six times the odds of being in fair/poor mental health, and more than twice the odds of having difficulties with activities of daily living. Results were similar for low life satisfaction and loneliness. Not surprisingly, people with the lowest immediate recall scores had almost twice the odds of reporting that they were at least somewhat forgetful, and almost four times the odds of reporting that they had some difficulty thinking clearly and solving problems, compared with people with the highest immediate recall scores. However, no association was shown between depression and immediate recall scores.

People with immediate recall scores in the lowest category had more than three times the odds of reporting a neurological condition and twice the odds of reporting a psychiatric disorder. (Odds ratios were generally similar for the other three measures of cognitive functioning, with the exception of psychiatric disorders and the MAT—Appendix Tables G, H and I).

Table 3
Stratum-specific likelihood ratios (SSLR) for selected health characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by immediate recall score, household population aged 45 or older, Canada excluding territories

	Immediate recall t-score														
	0 to 34			35 to 44			45 to 54			55 to 64			65 or more		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Health characteristic	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to
Low self-rated health	1.66	1.65	1.67	1.20	1.19	1.20	1.02	1.01	1.02	0.76	0.76	0.76	0.63	0.62	0.63
Low self-rated mental health	2.93	2.92	2.95	1.34	1.34	1.34	0.82	0.81	0.82	0.71	0.71	0.72	0.50	0.49	0.51
Difficulties with activities of daily living	1.62	1.61	1.63	1.18	1.17	1.18	1.00	1.00	1.00	0.79	0.78	0.79	0.67	0.66	0.67
Low life satisfaction	1.49	1.49	1.50	1.31	1.31	1.31	0.97	0.97	0.97	0.75	0.75	0.75	0.66	0.66	0.66
High probability of depression	1.07	1.06	1.08	1.05	1.05	1.06	1.00	1.00	1.00	0.78	0.78	0.79	1.46	1.45	1.47
High loneliness	1.79	1.78	1.80	1.18	1.18	1.19	0.93	0.93	0.93	0.83	0.82	0.83	0.80	0.80	0.81
Unable to remember things	1.51	1.50	1.52	1.10	1.10	1.10	0.97	0.97	0.97	0.89	0.89	0.89	0.86	0.86	0.87
Unable to think/solve problems	2.00	1.99	2.01	1.43	1.42	1.43	0.93	0.93	0.93	0.62	0.62	0.63	0.54	0.53	0.54
Neurological disorder	1.61	1.59	1.63	1.24	1.24	1.25	1.05	1.05	1.05	0.69	0.68	0.69	0.47	0.47	0.48
Vascular disorder	0.82	0.82	0.82	0.96	0.96	0.96	1.08	1.08	1.08	1.00	1.00	1.01	0.86	0.86	0.86
Psychiatric disorder	1.86	1.85	1.87	1.08	1.08	1.09	0.95	0.95	0.96	0.82	0.82	0.83	0.94	0.93	0.94

Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Table 4
Odds ratios relating selected health status characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by immediate recall score, household population aged 45 or older, Canada excluding territories

			Immediate recall t-score										
			0 to 34			35 to 44			45 to 54			55 to 64		
Health characteristic	Adjusted degrees of freedom	Adjusted chi-square	Odds ratio	95% confidence interval from	to	Odds ratio	95% confidence interval from	to	Odds ratio	95% confidence interval from	to	Odds ratio	95% confidence interval from	to
Low self-rated health	3.59	32.89	2.64	1.64	4.26	1.90	1.35	2.68	1.62	1.15	2.26	1.21	0.85	1.71
Low self-rated mental health	3.17	45.51	5.86	3.10	11.08	2.68	1.72	4.17	1.63	1.04	2.56	1.42	0.86	2.35
Difficulties with activities of daily living	3.63	25.65	2.42	1.51	3.90	1.76	1.19	2.59	1.50	1.03	2.18	1.17	0.79	1.74
Low life satisfaction	3.62	35.90	2.27	1.45	3.53	1.99	1.45	2.72	1.47	1.10	1.97	1.14	0.84	1.54
High probability of depression	3.71	6.19	0.73	0.39	1.39	0.72	0.43	1.23	0.69	0.41	1.15	0.54	0.31	0.92
High loneliness	3.93	27.73	2.23	1.47	3.39	1.48	1.05	2.06	1.16	0.83	1.61	1.03	0.74	1.44
Unable to remember things	3.84	16.23	1.76	1.20	2.58	1.28	0.97	1.69	1.12	0.86	1.47	1.03	0.77	1.38
Unable to think/solve problems	3.71	45.13	3.71	1.94	7.08	2.64	1.45	4.83	1.72	0.95	3.13	1.16	0.62	2.15
Neurological disorder	3.87	17.69	3.40	1.47	7.86	2.62	1.20	5.74	2.22	1.01	4.84	1.45	0.66	3.21
Vascular disorder	3.83	8.94	0.95	0.72	1.26	1.12	0.92	1.36	1.26	1.05	1.51	1.17	0.95	1.43
Psychiatric disorder	3.73	16.52	1.99	1.17	3.36	1.16	0.78	1.73	1.02	0.69	1.50	0.88	0.58	1.33

Note: Comparison group is 65 or more t-score category.
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Subgroup analyses

Validation conducted for people aged 45 to 64 and for those aged 65 or older, as well as for English and French respondents, yielded results similar to those obtained for the entire sample (results available upon request). Whether they were in the younger or older age group, English or French, respondents demonstrated similar patterns between health outcomes and the five categories of cognitive functioning (in both cross-tabulations and SSLR comparisons).

Regardless of their age group, people with low immediate recall scores were more likely to have fair/poor self-rated general and mental health, difficulties with activities of daily living, low life satisfaction, loneliness, less ability to think and solve problems, and neurological disorders, compared with people whose scores placed them in higher immediate recall categories. The only differences between the younger and older cohort were in memory and psychiatric disorders—lower immediate recall scores were not strongly associated with ability to remember things and psychiatric disorders among 45- to 64-year-olds, but they were for seniors.

For English and French respondents, lower immediate recall scores were associated with fair/poor self-rated general and mental health, difficulties with activities of daily living, low life satisfaction, loneliness, lower self-rated cognition, neurological disorders, and psychiatric disorders. Depression and vascular disorders were not associated with immediate recall scores for either language group.

Discussion

The results of the current study confirm that categories of cognitive functioning can be described from the CCHS—Healthy Aging Cognition Module. Four tests of cognitive functioning—immediate recall, delayed recall, animal-naming and the Mental Alternation Test—were validated based on literature-supported correlates of cognitive functioning. Lower cognitive functioning (notably, t-scores less than 34) was associated with poorer self-rated general and mental health, difficulties with activities of daily living, lower life satisfaction, and loneliness. As might be expected, self-reported cognitive difficulties (forgetfulness and difficulty thinking clearly and solving problems) were associated with low immediate recall scores. The fact that the strongest correlates of the cognitive functioning categories were self-rated mental health and difficulties thinking clearly and solving problems lends the greatest support to the use of the categories presented in this analysis.

Cognitive functioning was not associated with the probability of depression. However, the literature on this subject is inconsistent. Some studies have found no association between depression and cognition,[61] while others have shown a relationship, even accounting for socio-economic factors.[33] Beirman et al.[31] suggested a non-linear relationship between depression and cognitive decline, with elevated levels of depression (and anxiety) in the early stages of decline, but diminished levels as deterioration progresses. Further research on the association between depression and cognitive functioning is obviously necessary.

While neurological and psychiatric disorders were associated with lower cognitive functioning, no patterns emerged for vascular disorders. Previous work, too, has suggested that heart

disease, hypertension and diabetes are not necessarily associated with cognitive decline, especially over and above other risk factors such as low educational attainment.[33,62,63]

Limitations and future directions

A major strength of the current study is the large, nationally representative sample. However, several limitations should be acknowledged.

Proxy responses were not accepted for the Cognition Module. Other research has shown that individuals for whom proxy responses are provided tended to perform poorly on cognitive measures and were more likely to have dementia.[20] Thus, the CCHS—Healthy Aging data may underestimate the prevalence of lower cognitive functioning in the Canadian household population.

The CCHS—Healthy Aging Cognition Module used non-clinical measures of cognitive functioning. A clinical assessment would have allowed a test of sensitivity and specificity of the measures in identifying cognitive decline or dementia. This may explain why relationships were not found between vascular disorders (and/or depression) and the cognition categories. Muller et al.[64] found a significant relation between cardiovascular disease and MMSE scores, but not administered tests.

The longitudinal assessment of cognitive functioning among the population is warranted. Such studies would allow researchers to focus on associations between specific risk factors (or correlates) and cognitive functioning over time. For instance, Wilson et al.[36] found that loneliness was associated with a more rapid cognitive decline in elderly people.

Conclusions

Based on the results of tests of immediate and delayed recall, animal-naming, and the MAT in the CCHS—Healthy Aging Cognition Module, five categories describing low to high cognitive functioning were created. These categories were validated for the household population aged 45 or older overall, and by age group and language.

The aging of Canada's population will likely be accompanied by a growing number of people experiencing cognitive decline. CCHS—Healthy Aging data can contribute an understanding of the prevalence of this condition in the household population. This validation study enhances the analytic value of the information in the Cognition Module. ■

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Appendix

Table A
Percentage distribution of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by delayed recall score and selected health characteristics, household population aged 45 or older, Canada excluding territories

	Delayed recall t-score				
Health characteristic	Low 0 to 34	35 to 44	45 to 54	55 to 64	High 65 or more
			%		
Total	**5.6**	**23.7**	**39.2**	**23.4**	**8.1**
Self-perceived health					
Fair/Poor	5.8	29.1	40.6	19.2	5.2
Excellent/Very good/Good	5.6	22.8	39.0	24.1	8.5
Self-perceived mental health					
Fair/Poor	6.2[E]	36.2	40.6	12.9	4.2[E]
Excellent/Very good/Good	5.6	23.0	39.1	24.0	8.3
Activities of daily living					
No problems	6.6	31.4	38.1	18.0	5.9[E]
Mild/Moderate/Severe/Total problems	5.5	23.0	39.3	23.9	8.3
Life satisfaction					
Low	8.1	27.8	40.3	18.4	5.4
Not low	5.2	22.9	39.0	24.4	8.6
Depression					
0.9 probability or higher	6.9[E]	25.9	38.4	20.0	8.7[E]
Less than 0.9 probability	5.5	23.5	39.3	23.7	8.1
Loneliness					
High	7.9	26.0	38.5	21.0	6.6
Not high	5.3	23.3	39.4	23.7	8.3
Memory					
Able to remember most things	5.4	22.9	39.3	23.8	8.6
Somewhat forgetful/Very forgetful/Unable to remember anything	6.3	26.3	38.8	22.3	6.4
Ability to think clearly and solve problems					
Able to think clearly/solve problems	5.3	23.4	39.2	23.8	8.3
Having a little/some/great deal of difficulty/unable	9.9	27.1	39.2	19.1	4.6[E]
Neurological disorder					
Yes	9.8[E]	32.1	39.0	16.6	F
No	5.5	23.5	39.2	23.6	8.2
Vascular disorder					
Yes	4.6	25.0	39.8	23.0	7.6
No	6.4	22.7	38.8	23.7	8.4
Psychiatric disorder					
Yes	7.3	26.9	39.4	20.1	6.3
No	5.4	23.3	39.2	23.8	8.3

[E] interpret with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be reported (coefficient of variation greater than 33.3%)
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module

Table B
Percentage distribution of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by animal-naming score and selected health characteristics, household population aged 45 or older, Canada excluding territories

	Animal-naming t-score				
Health characteristic	Low 0 to 34	35 to 44	45 to 54	55 to 64	High 65 or more
			%		
Total	**7.4**	**24.9**	**36.6**	**23.2**	**7.8**
Self-perceived health					
Fair/Poor	9.0	30.0	37.3	18.4	5.3
Excellent/Very good/Good	7.1	24.0	36.5	24.0	8.3
Self-perceived mental health					
Fair/Poor	12.7	31.5	34.1	16.4	5.4[1]
Excellent/Very good/Good	7.1	24.5	36.8	23.6	8.0
Activities of daily living					
No problems	7.4	24.3	36.5	23.8	8.0
Mild/Moderate/Severe/Total problems	7.6	31.2	37.5	18.0	5.7
Life satisfaction					
Low	12.4	30.3	32.8	18.1	6.3
Not low	6.6	23.9	37.3	24.2	8.1
Depression					
0.9 probability or higher	9.2[1]	22.5	34.6	26.2	7.5
Less than 0.9 probability	7.3	25.0	36.7	23.1	7.8
Loneliness					
High	9.6	28.7	34.0	20.6	7.0
Not high	7.1	24.4	37.0	23.6	7.9
Memory					
Able to remember most things	6.7	24.4	37.1	23.5	8.3
Somewhat forgetful/Very forgetful/Unable to remember anything	9.7	26.6	35.2	22.4	6.2
Ability to think clearly and solve problems					
Able to think clearly/solve problems	6.9	24.5	36.7	23.8	8.1
Having a little/some/great deal of difficulty/unable	13.4	30.3	35.2	16.5	4.6[1]
Neurological disorder					
Yes	12.2	26.9	39.2	16.7	5.1[1]
No	7.3	24.9	36.5	23.4	7.9
Vascular disorder					
Yes	7.0	24.7	38.7	22.9	6.8
No	7.8	25.2	34.9	23.5	8.6
Psychiatric disorder					
Yes	8.3	27.3	37.3	21.9	5.2
No	7.3	24.7	36.5	23.4	8.1

[1] interpret with caution (coefficient of variation 16.6% to 33.3%)
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module

Table C
Percentage distribution of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by Mental Alternation Test score and selected health characteristics, household population aged 45 or older, Canada excluding territories

	Mental Alternation Test t-score				
Health characteristic	Low 0 to 34	35 to 44	45 to 54	55 to 64	High 65 or more
			%		
Total	6.5	23.2	36.4	26.0	7.9
Self-perceived health					
Fair/Poor	8.4	32.4	36.7	17.7	4.9
Excellent/Very good/Good	6.1	21.7	36.3	27.4	8.4
Self-perceived mental health					
Fair/Poor	10.0	32.8	32.1	20.3	4.8[1]
Excellent/Very good/Good	6.2	22.7	36.6	26.4	8.1
Activities of daily living					
No problems	6.4	22.4	36.2	26.8	8.2
Mild/Moderate/Severe/Total problems	7.3	30.6	37.6	19.2	5.3
Life satisfaction					
Low	9.0	28.9	34.6	21.8	5.6
Not low	6.0	22.2	36.8	26.8	8.3
Depression					
0.9 probability or higher	6.9[1]	25.1	34.7	28.1	5.2[1]
Less than 0.9 probability	6.4	23.0	36.6	25.9	8.1
Loneliness					
High	8.6	26.6	36.1	22.7	6.0
Not high	6.2	22.7	36.5	26.4	8.2
Memory					
Able to remember most things	6.2	22.3	36.6	26.5	8.4
Somewhat forgetful/Very forgetful/Unable to remember anything	7.3	26.1	35.6	24.5	6.4
Ability to think clearly and solve problems					
Able to think clearly/solve problems	6.0	22.6	36.3	26.8	8.3
Having a little/some/great deal of difficulty/unable	11.4	30.8	36.8	17.5	3.6
Neurological disorder					
Yes	11.9[1]	29.5	34.2	18.6	5.8[1]
No	6.3	23.1	36.4	26.3	8.0
Vascular disorder					
Yes	6.4	24.7	37.2	23.6	8.2
No	6.5	22.0	35.8	28.0	7.7
Psychiatric disorder					
Yes	7.1	25.6	33.4	27.4	6.6[1]
No	6.4	23.0	36.7	25.9	8.1

[1] interpret with caution (coefficient of variation 16.6% to 33.3%)
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module

Table D
Stratum-specific likelihood ratios (SSLR) for selected health characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by delayed recall score category, household population aged 45 or older, Canada excluding territories

	Delayed recall t-score														
	0 to 34			35 to 44			45 to 54			55 to 64			65 or more		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Health characteristic	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to
Low self-rated health	1.03	1.02	1.04	1.28	1.27	1.28	1.04	1.04	1.04	0.80	0.80	0.80	0.62	0.61	0.62
Low self-rated mental health	1.10	1.09	1.11	1.57	1.57	1.58	1.04	1.03	1.04	0.54	0.53	0.54	0.51	0.50	0.52
Difficulties with activities of daily living	1.19	1.18	1.20	1.37	1.36	1.37	0.97	0.97	0.97	0.75	0.75	0.75	0.71	0.71	0.72
Low life satisfaction	1.57	1.56	1.58	1.21	1.21	1.22	1.03	1.03	1.04	0.76	0.75	0.76	0.63	0.62	0.63
High probability of depression	1.09	1.08	1.10	1.11	1.10	1.11	0.96	0.96	0.97	0.87	0.86	0.87	1.20	1.19	1.21
High loneliness	1.49	1.48	1.50	1.12	1.11	1.12	0.98	0.98	0.98	0.88	0.88	0.89	0.79	0.79	0.80
Unable to remember things	1.16	1.15	1.16	1.15	1.14	1.15	0.99	0.98	0.99	0.94	0.94	0.94	0.74	0.74	0.75
Unable to think/solve problems	1.87	1.85	1.88	1.16	1.15	1.16	1.00	1.00	1.00	0.81	0.80	0.81	0.56	0.55	0.56
Neurological disorder	1.77	1.75	1.79	1.37	1.36	1.38	0.99	0.99	1.00	0.70	0.70	0.71	0.31	0.31	0.32
Vascular disorder	0.71	0.71	0.72	1.10	1.10	1.10	1.03	1.03	1.03	0.97	0.97	0.97	0.91	0.90	0.91
Psychiatric disorder	1.34	1.33	1.35	1.16	1.15	1.16	1.00	1.00	1.01	0.84	0.84	0.85	0.77	0.76	0.77

Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module

Table E
Stratum-specific likelihood ratios (SSLR) for selected health characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by animal-naming score category, household population aged 45 or older, Canada excluding territories

	Animal-naming t-score														
	0 to 34			35 to 44			45 to 54			55 to 64			65 or more		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Health characteristic	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to
Low self-rated health	1.27	1.26	1.27	1.25	1.24	1.25	1.02	1.02	1.02	0.77	0.76	0.77	0.64	0.64	0.65
Low self-rated mental health	1.78	1.77	1.79	1.29	1.28	1.29	0.93	0.92	0.93	0.69	0.69	0.70	0.67	0.67	0.68
Difficulties with activities of daily living	1.02	1.01	1.03	1.28	1.28	1.29	1.03	1.03	1.03	0.76	0.75	0.76	0.71	0.71	0.72
Low life satisfaction	1.89	1.89	1.90	1.27	1.27	1.27	0.88	0.88	0.88	0.75	0.75	0.75	0.78	0.78	0.79
High probability of depression	1.20	1.19	1.20	0.87	0.87	0.87	0.98	0.98	0.98	1.16	1.16	1.17	0.86	0.85	0.86
High loneliness	1.36	1.35	1.37	1.18	1.17	1.18	0.92	0.92	0.92	0.87	0.87	0.88	0.89	0.88	0.89
Unable to remember things	1.43	1.43	1.44	1.09	1.09	1.09	0.95	0.95	0.95	0.95	0.95	0.96	0.75	0.74	0.75
Unable to think/solve problems	1.94	1.93	1.95	1.24	1.23	1.24	0.96	0.96	0.96	0.69	0.69	0.70	0.57	0.57	0.58
Neurological disorder	1.67	1.66	1.69	1.08	1.07	1.09	1.07	1.07	1.08	0.71	0.71	0.72	0.64	0.63	0.65
Vascular disorder	0.90	0.89	0.90	0.98	0.98	0.98	1.11	1.11	1.11	0.97	0.97	0.98	0.78	0.78	0.79
Psychiatric disorder	1.13	1.12	1.13	1.11	1.10	1.11	1.02	1.02	1.02	0.94	0.93	0.94	0.64	0.64	0.65

Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module

Table F
Stratum-specific likelihood ratios (SSLR) for selected health characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by Mental Alternation Test score category, household population aged 45 or older, Canada excluding territories

	Mental Alternation Test t-score														
	0 to 34			35 to 44			45 to 54			55 to 64			65 or more		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Health characteristic	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to
Low self-rated health	1.36	1.35	1.37	1.49	1.49	1.50	1.01	1.01	1.01	0.64	0.64	0.65	0.58	0.58	0.59
Low self-rated mental health	1.61	1.59	1.62	1.45	1.44	1.45	0.88	0.87	0.88	0.77	0.76	0.77	0.59	0.59	0.60
Difficulties with activities of daily living	1.15	1.15	1.16	1.36	1.36	1.37	1.04	1.03	1.04	0.72	0.71	0.72	0.65	0.64	0.65
Low life satisfaction	1.51	1.50	1.52	1.31	1.30	1.31	0.94	0.94	0.94	0.81	0.81	0.82	0.68	0.68	0.68
High probability of depression	1.11	1.10	1.12	1.04	1.04	1.05	0.97	0.97	0.98	1.08	1.08	1.09	0.65	0.64	0.66
High loneliness	1.40	1.39	1.41	1.17	1.17	1.17	0.99	0.99	0.99	0.86	0.86	0.86	0.73	0.72	0.73
Unable to remember things	1.18	1.17	1.18	1.17	1.17	1.17	0.97	0.97	0.98	0.93	0.92	0.93	0.77	0.76	0.77
Unable to think/solve problems	1.88	1.87	1.89	1.36	1.36	1.37	1.01	1.01	1.01	0.65	0.65	0.66	0.43	0.43	0.44
Neurological disorder	1.88	1.86	1.90	1.28	1.27	1.29	0.94	0.94	0.94	0.71	0.70	0.71	0.73	0.72	0.74
Vascular disorder	0.98	0.97	0.98	1.12	1.12	1.12	1.04	1.04	1.04	0.84	0.84	0.84	1.06	1.05	1.06
Psychiatric disorder	1.11	1.10	1.12	1.12	1.11	1.12	0.91	0.91	0.91	1.06	1.05	1.06	0.81	0.81	0.82

Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module

Table G
Odds ratios relating selected health status characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by delayed recall score, household population aged 45 or older, Canada excluding territories

			Delayed recall t-score									
			0 to 34			35 to 44			45 to 54			55 to 64		
	Adjusted degrees of freedom	Adjusted chi-square	Odds ratio	95% confidence interval		Odds ratio	95% confidence interval		Odds ratio	95% confidence interval		Odds ratio	95% confidence interval	
Health characteristic				from	to		from	to		from	to		from	to
Low self-rated health	3.89	28.86	1.67	1.10	2.53	2.07	1.44	2.98	1.69	1.21	2.35	1.30	0.91	1.83
Low self-rated mental health	3.43	38.94	2.16	1.24	3.74	3.08	1.91	4.98	2.03	1.29	3.21	1.05	0.65	1.69
Difficulties with activities of daily living	3.30	23.94	1.67	0.97	2.90	1.92	1.18	3.14	1.36	0.84	2.21	1.05	0.64	1.73
Low life satisfaction	3.71	29.47	2.51	1.64	3.82	1.93	1.40	2.67	1.65	1.24	2.20	1.21	0.89	1.65
High probability of depression	3.86	3.07	1.17	0.60	2.27	1.02	0.63	1.67	0.90	0.56	1.47	0.78	0.46	1.34
High loneliness	3.97	12.05	1.88	1.22	2.89	1.41	1.00	1.98	1.23	0.88	1.73	1.11	0.79	1.57
Unable to remember things	3.93	10.67	1.56	1.07	2.27	1.55	1.17	2.04	1.33	1.01	1.74	1.26	0.94	1.70
Unable to think/solve problems	3.77	18.96	3.36	1.72	6.58	2.09	1.15	3.80	1.80	0.98	3.30	1.45	0.76	2.75
Neurological disorder	3.77	20.40	5.65	2.34	13.66	4.38	1.97	9.72	3.17	1.43	7.06	2.25	0.98	5.14
Vascular disorder	3.93	12.07	0.79	0.58	1.07	1.21	0.96	1.53	1.13	0.92	1.40	1.07	0.86	1.32
Psychiatric disorder	3.88	9.67	1.75	1.07	2.84	1.51	1.04	2.19	1.31	0.91	1.88	1.10	0.75	1.61

Note: Comparison group is 65 or more t-score category.
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module

Table H
Odds ratios relating selected health status characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by animal-naming score, household population aged 45 or older, Canada excluding territories

			Animal-naming t-score										
			0 to 34			35 to 44			45 to 54			55 to 64		
				95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Health characteristic	Adjusted degrees of freedom	Adjusted chi-square	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to
Low self-rated health	3.82	39.18	1.97	1.42	2.75	1.95	1.50	2.53	1.59	1.24	2.04	1.19	0.91	1.57
Low self-rated mental health	3.62	27.76	2.64	1.59	4.38	1.91	1.19	3.06	1.38	0.88	2.14	1.03	0.69	1.55
Difficulties with activities of daily living	3.92	34.77	1.43	0.98	2.09	1.80	1.30	2.48	1.44	1.05	1.97	1.06	0.77	1.47
Low life satisfaction	3.70	57.94	2.42	1.70	3.43	1.62	1.23	2.14	1.12	0.85	1.48	0.96	0.71	1.28
High probability of depression	3.55	3.60	1.31	0.76	2.25	0.94	0.66	1.33	0.98	0.70	1.39	1.18	0.82	1.72
High loneliness	3.86	14.20	1.53	1.02	2.30	1.33	0.97	1.82	1.04	0.77	1.40	0.98	0.72	1.34
Unable to remember things	3.68	19.96	1.92	1.43	2.58	1.46	1.17	1.81	1.27	1.03	1.56	1.28	1.01	1.61
Unable to think/solve problems	3.67	36.37	3.38	2.09	5.47	2.16	1.44	3.24	1.67	1.12	2.50	1.21	0.77	1.90
Neurological disorder	3.78	13.17	2.61	1.20	5.66	1.68	0.84	3.37	1.67	0.85	3.30	1.11	0.51	2.41
Vascular disorder	3.90	13.50	1.14	0.87	1.50	1.25	1.03	1.52	1.41	1.17	1.71	1.24	1.02	1.52
Psychiatric disorder	3.68	7.87	1.75	1.16	2.65	1.72	1.25	2.36	1.59	1.18	2.13	1.46	1.06	2.00

Note: Comparison group is 65 or more t-score category.
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Table I
Odds ratios relating selected health status characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by Mental Alternation Test score, household population aged 45 or older, Canada excluding territories

			Mental Alternation Test t-score										
			0 to 34			35 to 44			45 to 54			55 to 64		
				95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Health characteristic	Adjusted degrees of freedom	Adjusted chi-square	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to
Low self-rated health	3.83	99.35	2.34	1.67	3.28	2.56	1.95	3.37	1.74	1.31	2.30	1.11	0.84	1.46
Low self-rated mental health	3.78	26.20	2.71	1.55	4.74	2.44	1.38	4.32	1.48	0.86	2.55	1.30	0.74	2.27
Difficulties with activities of daily living	3.92	57.02	1.78	1.25	2.51	2.10	1.58	2.79	1.60	1.20	2.12	1.10	0.83	1.47
Low life satisfaction	3.89	42.25	2.23	1.54	3.23	1.92	1.44	2.57	1.39	1.06	1.81	1.20	0.90	1.59
High probability of depression	3.90	4.80	1.69	0.93	3.07	1.70	1.07	2.71	1.48	0.94	2.32	1.68	1.06	2.67
High loneliness	3.78	16.45	1.92	1.26	2.92	1.60	1.18	2.19	1.36	1.00	1.85	1.18	0.86	1.62
Unable to remember things	3.89	15.72	1.53	1.11	2.11	1.52	1.19	1.94	1.27	1.01	1.58	1.20	0.94	1.54
Unable to think/solve problems	3.59	47.03	4.35	2.67	7.09	3.15	2.15	4.60	2.34	1.61	3.39	1.51	1.00	2.29
Neurological disorder	3.87	21.92	2.58	1.28	5.22	1.76	0.98	3.16	1.29	0.70	2.36	0.97	0.51	1.83
Vascular disorder	3.95	17.98	0.92	0.71	1.20	1.06	0.87	1.30	0.98	0.81	1.18	0.80	0.65	0.97
Psychiatric disorder	3.93	4.96	1.37	0.83	2.25	1.37	0.90	2.09	1.12	0.75	1.68	1.30	0.86	1.96

Note: Comparison group is 65 or more t-score category.
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.